AES Hawaii, Inc.
A Subsidiary of The AES Corporation
The Global Power Company

April 7, 2000

Emission Measurement Center (MD-19)
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

Attention: Mr. William Grimley/Ms. Lara Autry

Dear Mr. Grimley/Ms. Autry,

Mercury Emissions Testing
Report Submission

In accordance with your letter dated March 11, 1999, please find enclosed AES Hawaii, Inc.'s Mercury Emission Testing Report. The testing was completed by Best Environmental, Inc. in accordance with the test plan previously approved by your department. We trust that this report satisfies the requirements of your request, but should you have any questions, please do not hesitate to contact me at (808) 682-3412, fax at (808) 682-4915, or e-mail at tkanja@aesc.com.

Sincerely,

Todd Kanja
Plant Engineer

Cc: P. Murphy
M. Patton
K. Pierce
J. Shin
J. Vaughan

91-086 Kaomi Loop • Kapolei, Hawaii 96707 • Phone (808) 682-5330 • Fax (808) 682-4915

BEST ENVIRONMENTAL, INC.

15890 Foothill Boulevard
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Source Test Report

Electric Utility Steam Generation Unit
Mercury Test Program
AES Hawaii, Inc.
91-086 Kaomi Loop
Kapolei, HI 96707

Prepared By:
Best Environmental, Inc
15890 Foothill Boulevard
San Leandro, CA 94578
March 10, 2000

REVIEW AND CERTIFICATION

Team Leader:

The work performed herein was conducted under my supervision, and I certify that the details and results contained within this report are to the best of my knowledge an authentic and accurate representation of the test program. If this report is submitted for Compliance purposes it should only be reproduced in its entirety. If there are any questions concerning this report, please the Team Leader, Reviewer or Craig Thiry at (510) 278-4011.

Scott Chesnut
Senior Project Manager

Reviewer:

I have reviewed this report for presentation and accuracy of content, and hereby certify that to the best of my knowledge the information is complete and correct.

Dan Carter

for Guy Worthington
Senior Project Manager

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1.0 Introduction

1.1 Summary of Test Program

The U.S. Environmental Protection Agency (EPA) has determined that mercury emissions from coal-fired utilities are the hazardous air pollutant (HAP) that poses the greatest danger to public health. In order to determine whether regulation is necessary for coal-fired utilities, the EPA has issued an information collection request (ICR) to collect further data. The data collected will provide updated quantitative, speciation and controllability information for mercury emissions.

AES Hawaii, Inc. (AES), operates two coal-fired boilers (Units A & B) at their Kapolei, Hawaii facility. Their facility was statistically selected to provide speciated mercury analysis information, from one of the two units, under the ICR. The inlet and outlet of the B Boiler's baghouse was tested simultaneously for mercury emissions. "The Standard Method for Elemental, Oxidized, Particle-Bound and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method) was used to determine emissions from the boiler. In addition to the baghouse sampling, coal fuel samples were collected for analysis of mercury content.

AES contracted Best Environmental, Inc. (BEI), to perform the Source Testing at their facility.

1.2 Key Personnel

The following Table 1.2-1 lists the members of the test program and their responsibilities.

TABLE 1.2-1 TEST PROGRAM ORGANIZATION

Title	Name	Responsibilities
Test Director	Pat Murphy Vice-President AES Hawaii, Inc. 808.682.5330	Oversees plant's aspects of the test program including coordination with Hawaiian Electric during testing
Plant Contact	Mel Patton AES Hawaii, Inc. 808.682.3436	Coordination of plant and Source Test Team. Provide plant operation data and fuel samples
Control Room Operator	As Assigned AES Hawaii, Inc. 808.682.3436	Operation of Boilers. Communicates with Plant Contact as to plant's status.
Project Manager	Scott Chesnut Best Environmental, Inc. 510.278.4011	Coordination between Source Test Team and Plant. Collection of all test, plant and laboratory data necessary for production of report. Writing report.
Quality Coordinator	Guy Worthington Best Environmental, Inc. 510.278.4011	Review all aspect of testing covered in the Quality Assurance Project Plan On-site data review. Report Review
Laboratory Coordinator	Mike Wiley Best Environmental, Inc. 510.278.4011	Preparation and recovery of sample trains. Blank preparation, Chain of Custody and shipping of samples.

TABLE 1.2-1 (CONT.) TEST PROGRAM ORGANIZATION

Title	Name	Responsibilities
Inlet Sample Team Leader	Jeff Mesloh Best Environmental, Inc. 510.278.4011	Coordinate with Project Manager for collecting samples. Collect samples. Performing all on-stack QA/QC checks required by sample method.
Outlet Sample Team Leader	Robert Chute Best Environmental, Inc. 510.278.4011	Coordinate with Project Manager for collecting samples. Collect samples. Performing all on-stack QA/QC checks required by sample method.
Client Services Representative (Flue Gas Samples)	Ron McLeod Philip Analytical Services 800.668.0639 Ext. 236	Coordinate between Project Manager and laboratory receipt and analysis of flue gas samples. Provide all required QA/QC documentation required by method and QAPP.
Client Services Representative (Coal Samples)	Tim Hutchison Standard Laboratories 618.539.5836	Coordinate between Project Manager and laboratory receipt and analysis of coal samples. Provide all required QA/QC documentation required by methods and QAPP.

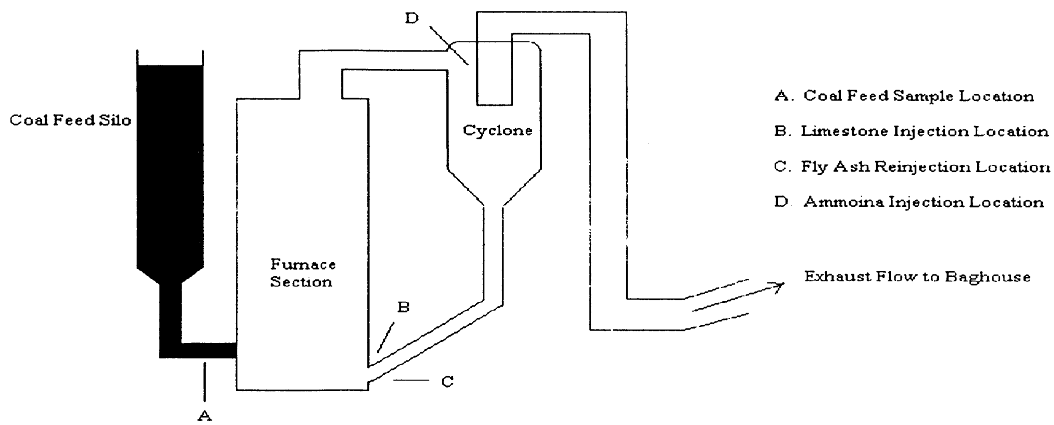
2.0 Plant and Sampling Location Descriptions

2.1 Process Description and Operation

AES Hawaii, Inc. (AES) operates two identical 90-megawatt coal-fired boilers at their facility at 91-086 Kaomi Loop, Kapolei, Hawaii. The "A" and "B" boilers are Circulating Fluidizing Bed Boilers rated at 90 MW of power production. Steam, from both boilers, drives a single 180-megawatt steam turbine. Steam can also be exported to the adjacent refinery.

Fuel for the units is bituminous coal shipped to Hawaii from Indonesia. Shipments are received approximately once a month at the Barbers Point Harbor Terminal. The coal is transported to the facility via an ~1.5 mile conveyor.

FIGURE 2.1-1 BOILER DIAGRAM.



AES Hawaii Boiler Diagram

2.2 Control Equipment Description

Each unit has the following control equipment installed:

- Ammonia injection for NO_x control.
- Limestone injection for SO_2 control.
- Cyclone for ash re-injection and particulate matter control.
- Fabric filter baghouse for particulate matter control.

2.3 Sampling Locations

2.3.1 Flue Gas Sampling Locations

Sampling was performed at the inlet and outlet to the baghouse. The inlet and outlet sample locations are similar in layout. Samples were taken from six-6 inch diameter ports (Numbered 1-6) 36.5 inches in depth. The ports were mounted vertically on top of the inlet and outlet duct. Each port was traversed at five points (30 total points) with each point sampled for five minutes for a 150-minute sample.

The inlet ports are less than 0.5 equivalent diameters downstream and less than 0.5 equivalent diameters upstream of flow disturbances. The outlet ports are 2.0 equivalent diameters downstream and 0.5 equivalent diameters upstream of flow disturbances.

Figure 2.3-1 illustrates the sample locations. In addition to the illustration, photographs of the inlet and outlet are attached to the appendix.

The baghouse is located just before the I.D. fan and both sample locations are under heavy vacuum (16" to 20" H_2O). The high vacuum necessitated starting the sample train before the probe was inserted into the port. Due to this situation, the sample trains were not stopped between port changes.

FIGURE 2.3-1 INLET/OUTLET CROSS-SECTIONAL VIEW

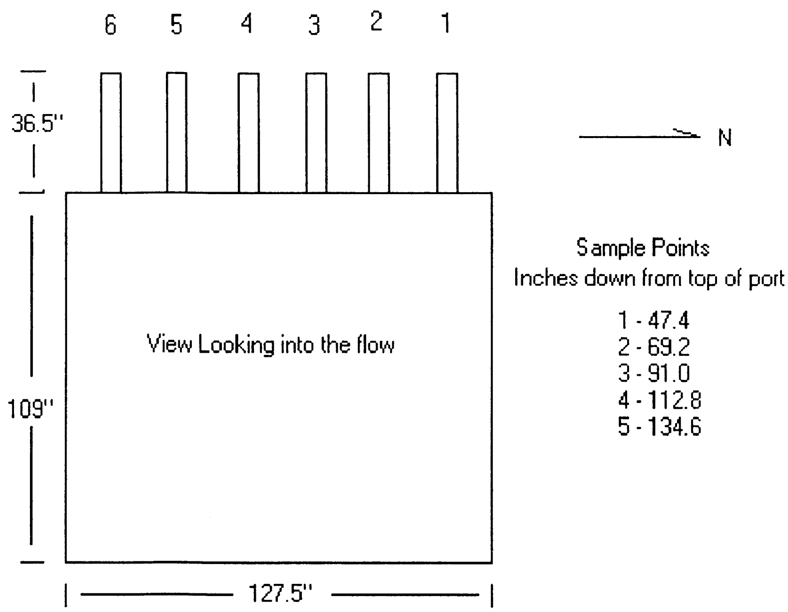
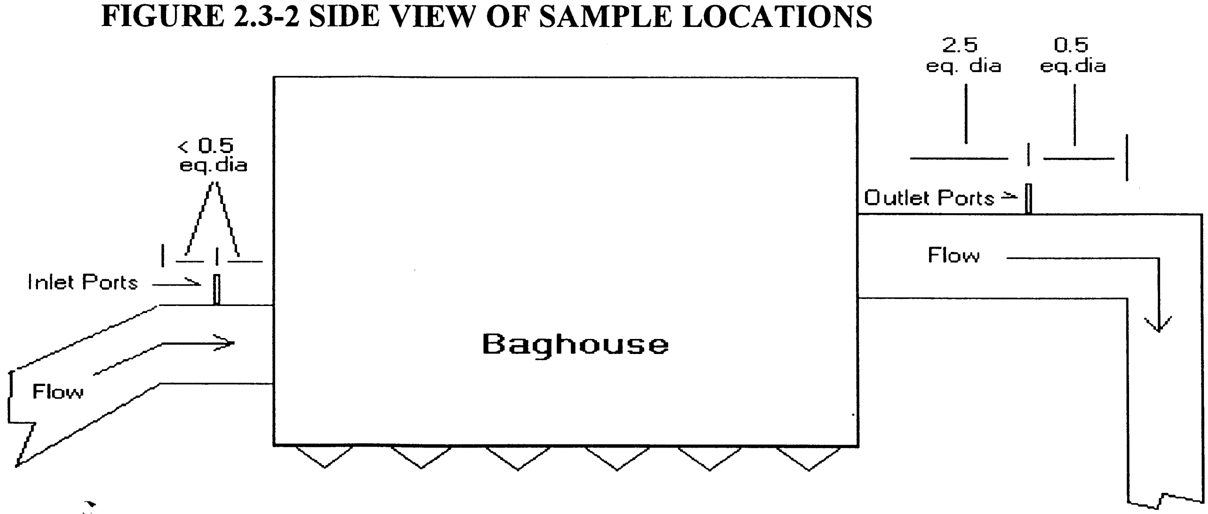


FIGURE 2.3-2 SIDE VIEW OF SAMPLE LOCATIONS



2.3.2 Process Sampling Locations

The coal fuel samples were taken at the bottom of the feed silos at a location just before the coal enters the boiler. This was the closest point to the boiler that samples can be taken. Samples were taken at 10-minute intervals simultaneously with the inlet/outlet mercury sample runs. The coal samples were combined and homogenized into a single sample per run.

3.0 Summary and Discussions of Test Results

3.1 Objectives and Test Matrix

The objective of the test program is to quantify particle-bound, gaseous and oxidized mercury emissions from coal-fired electric utilities. The specific objectives are as follows:

- Measure simultaneously the flue gas levels of particle-bound, gaseous and oxidized mercury at the inlet and outlet to the baghouse.
- Measure mercury levels in the feed coal for the boiler.
- Obtain plant operational data during flue gas sampling periods.

Table 3.1-1 presents the sampling and analytical matrix and sampling log.

TABLE 3.1-1. TEST MATRIX

Sampling Location	Run #	Date	Clock Time	Sample Run Time (min)	Sample/Type Pollutant	Sampling Method	Sampling Organization
Baghouse Outlet	1	1/11/00	1423-1713	150	P-B, G & O Hg	Ontario Hydro	BEI
Baghouse Outlet	1	"	1423-1713	150	O_2/CO_2	M3 (bag)	BEI
Baghouse Inlet	1	"	1423-1713	150	P-B, G & O Hg	Ontario Hydro	BEI
Baghouse Inlet	1	"	1423-1713	150	O_2/CO_2	M3 (bag)	BEI
Fuel Silo	1	"	1420-1720	180	Hg	ASTM D 2234-99	AES
Baghouse Outlet	2	1/12/00	0914-1211	150	P-B, G & O Hg	Ontario Hydro	BEI
Baghouse Outlet	2	"	0914-1211	150	O_2/CO_2	M3 (bag)	BEI
Baghouse Inlet	2	"	0914-1209	150	P-B, G & O Hg	Ontario Hydro	BEI
Baghouse Inlet	2	"	0914-1209	150	O_2/CO_2	M3 (bag)	BEI
Fuel Silo	2	"	0910-1210	180	Hg	ASTM D 2234-99	AES
Baghouse Outlet	3	1/12/00	1342-1639	150	P-B, G & O Hg	Ontario Hydro	BEI
Baghouse Outlet	3	"	1342-1639	150	O_2/CO_2	M3 (bag)	BEI
Baghouse Inlet	3	"	1343-1632	150	P-B, G & O Hg	Ontario Hydro	BEI
Baghouse Inlet	3	"	1343-1632	150	O_2/CO_2	M3 (bag)	BEI
Fuel Silo	3	"	1340-1640	180	Hg	ASTM D 2234-99	AES

P-B, G & O Hg = Particle-Bound, Gaseous & Oxidized Mercury
O_2/CO_2 = Oxygen and Carbon dioxide

3.2 Field Test Changes and Problems

3.2.1 Method 3 Sample Lost

The Method 3 Fyrite sample for the Inlet's Run 3 was lost due to a leak in the Tedlar sample bag. The values for O_2 and CO_2 were assumed to be equal to those obtained for the previous test runs, since they matched closely between the first two runs.

3.2.2 Outlet Sample Problems

Run 1 at the Outlet had the probe temperature fall below 248 °F briefly. The temperature controller setting was increased and the temperature was brought above 248 °F. At the outlet on Run 3, the sample line was also pulled out from the filter, so there was an eight minute delay while the train was leak checked. Neither of these events are thought to have a significant impact on the results.

3.3 Presentation of Results

3.3.1 Inlet and Outlet Mercury Emissions Results

The test program was designed to present the quantitative, speciation and controllability information for mercury emissions from the Boiler B baghouse. Inlet and outlet concentrations and emissions rates for the mercury species are presented in Table 3.3-1.

The following observations are made:

- The flow rates at the inlet and outlet are within ±3.9% for each run.
- The temperature measurements of the inlet and outlet are within ±7 degrees during each run.
- Particle-bound and oxidized mercury were not detectable at the outlet.
- Total mercury was reduced by >50% between the inlet and outlet.

TABLE 3.3-1 Elemental, Oxidized, Particle-Bound and Total Mercury Inlet & Outlet Results

	Units	Inlet 1	Inlet 2	Inlet 3	AVERAGE	Outlet 1	Outlet 2	Outlet 3	AVERAGE
Test Date		01/11/00	01/12/00	01/12/00		01/11/00	01/12/00	01/12/00	
Test Time		1423-1713	914-1209	1343-1632		1423-1713	914-1211	1342-1639	
Sample Volume	DSCM	1.766	1.816	1.817		3.307	3.387	3.369	
Isokinetic Variation	%	93.3	93.2	94.1		100.0	99.6	100.2	
Duct Temperature	°F	278.9	275.4	279.0	**277.2**	272.7	271.7	272.7	**272.2**
Velocity	M/sec	28.72	28.79	28.64	**28.76**	28.85	28.87	28.79	**28.86**
Flow Rate	ACMM	11,033	11,218	11,330	**11,125**	10,494	10,776	10,742	**10,635**
Flow Rate	DSCMM	6,922	7,127	7,065	**7,024**	6,664	6,856	6,776	**6,760**
H_2O	vol.%	8.7	8.1	9.4	**8.4**	7.7	7.5	8.2	**7.6**
O_2	vol.%	8.0	8.0	8.0 *	**8.0**	8.0	8.0	8.0	**8.0**
CO_2	vol.%	11.7	11.7	11.7 *	**11.7**	11.8	12.0	12.0	**11.9**
Particle Bound Hg Conc. (Hg_{TP})	μg/m³	1.9E-01	2.5E-01	2.6E-01	**2.2E-01**	<3.0E-03	<3.0E-03	<3.0E-03	**<3.0E-03**
Particle Bound Hg Em. Rate (ER_{HgTP})	mg/min	1.3E+00	1.8E+00	1.9E+00	**1.5E+00**	<2.0E-02	<2.0E-02	<2.0E-02	**<2.0E-02**
Oxidized Hg Conc. (Hg_{2+})	μg/m³	<5.7E-02	1.2E-01	7.7E-02	**8.6E-02**	<3.0E-02	<3.0E-02	<3.0E-02	**<3.0E-02**
Oxidized Hg Em. Rate (ER_{Hg2+})	mg/min	<3.9E-01	8.2E-01	5.4E-01	**6.1E-01**	<2.0E-01	<2.0E-01	<2.0E-01	**<2.0E-01**
Elemental Hg Conc. (Hg_0)	μg/m³	9.3E-01	1.0E+00	8.5E-01	**9.9E-01**	4.9E-01	6.5E-01	4.0E-01	**5.7E-01**
Elemental Hg Em. Rate (E_{Hg0})	mg/min	6.4E+00	7.4E+00	6.0E+00	**6.9E+00**	3.3E+00	4.4E+00	2.7E+00	**3.9E+00**
Total Hg Conc. (Hg_T)	μg/m³	1.2E+00	1.4E+00	1.2E+00	**1.3E+00**	5.3E-01	6.8E-01	4.4E-01	**6.0E-01**
Total Hg Em. Rate (ER_{HgT})	mg/min	8.1E+00	1.0E+01	8.4E+00	**9.0E+00**	3.5E+00	4.7E+00	3.0E+00	**4.1E+00**

* Assumed Values

3.2.3 Coal Mercury and Chlorine Feed Results

In addition to the mercury emissions testing of the baghouse, sampling the coal feed to the boiler was sampled in order to determine the amounts of chlorine and mercury going into the boiler. The results of the coal sampling and analysis are presented in Table 3.3-2.

TABLE 3.3-2 Coal Feed Mercury and Chlorine Results

	Units	Run 1	Run 2	Run 3	Average
Coal Flow Rate	kg/hr	37,676	38,252	38,488	**38,138**
Coal Mercury Concentration	ppm	0.030	0.030	0.020	**0.027**
Coal Mercury Feed Rate	mg/hr	1.13E+03	1.15E+03	7.70E+02	**1.02E+03**
Coal Chlorine Concentration	ppm	60	<50	52	**54**
Coal Chlorine Feed Rate	mg/hr	2.26E+06	<1.91E+06	2.00E+06	**2.06E+06**

TABLE 3.3-3 Mercury Reduction Results

	Units	Inlet AVERAGE	Outlet AVERAGE	Reduction %
Particle Bound Hg Conc. (Hg_{TP})	$\mu g/m^3$	2.2E-01	<3.0E-03	**98.6%**
Particle Bound Hg Em. Rate (ER_{HgTP})	mg/min	1.5E+00	<2.0E-02	**98.7%**
Oxidized Hg Conc. (Hg_{2+})	$\mu g/m^3$	8.6E-02	<3.0E-02	**65.3%**
Oxidized Hg Em. Rate (ER_{Hg2+})	mg/min	6.1E-01	<2.0E-01	**66.7%**
Elemental Hg Conc. (Hg_0)	$\mu g/m^3$	9.9E-01	5.7E-01	**42.2%**
Elemental Hg Em. Rate (ER_{Hg0})	mg/min	6.9E+00	3.9E+00	**44.0%**
Total Hg Conc. (Hg_T)	$\mu g/m^3$	1.3E+00	6.0E-01	**53.2%**
Total Hg Em. Rate (ER_{HgT})	mg/min	9.0E+00	4.1E+00	**54.8%**

4.0 Sampling and Analytical Procedures

4.1 Test Methods

4.1.1 The Standard Method for Elemental, Oxidized, Particle-Bound and Total Mercury in Flue Gas Generated from Coal-Fired Stationary Sources (Ontario Hydro Method).

The Ontario Hydro Method is an isokinetic method for determining speciated mercury emissions. Equipment consisted of a glass nozzle, glass-lined probe, heated filter box, heated umbilical, seven glass impingers, and a meter control module.

The probe is a Method 5 arrangement with a borosilicate glass nozzle and glass liner, followed by a heated filter and heated Teflon line which reaches to the impingers. The first two impingers were charged with KCl and the next is charged with acidic H_2O_2, the fourth, fifth and the sixth impingers contain acidic $KMnO_4$ solution and the final impinger contained silica gel.

The probe and nozzle rinse was with 0.1 Normal HNO_3 only and no particulate gravimetric analysis was performed.

BEI's Method 5 equipment has been physically inspected and certified by the California Air Resources Board (CARB). Isokinetics were determined by using a programmed HP calculator. All mandatory data was recorded on a BEI data sheet. Leak checks were performed before and after each test run and before and after component changes. Full and post-test meter calibrations as well as probe and nozzle calibrations are included in the Appendix.

Upon completion of each test run the filters, sample lines and impingers were moved to the AES Laboratory area and were recovered by the Laboratory Coordinator. The probes and nozzles were recovered at the sample locations. Data sheets were checked by the Quality Coordinator to insure valid results.

Figure 4.1-1 is a schematic of the Ontario Hydro Sampling System and Figure 4.1-2 diagrams the sample train recovery scheme. Figure 4.1-3 diagrams the analytical scheme for the mercury samples.

4.1.2 EPA Method 3 Gas Analysis for Dry Molecular Weight Determination

Stack gas is collected in a Tedlar bag throughout the Ontario Hydro test runs. The gas samples were analyzed after each run using a Fyrite apparatus.

4.2 Process Data

In order to verify the operation of the plant during the test program, plant process data collection and coal feed sampling was performed. The plant's process data was collected at the end of each sample day and this data is located in Appendix B. The reports present hourly averages for the following parameters:

- Generator output
- Boiler fuel feed rate
- Steam production
- Ammonia injection rate
- Limestone injection rate
- Plant CEM CO_2 Data

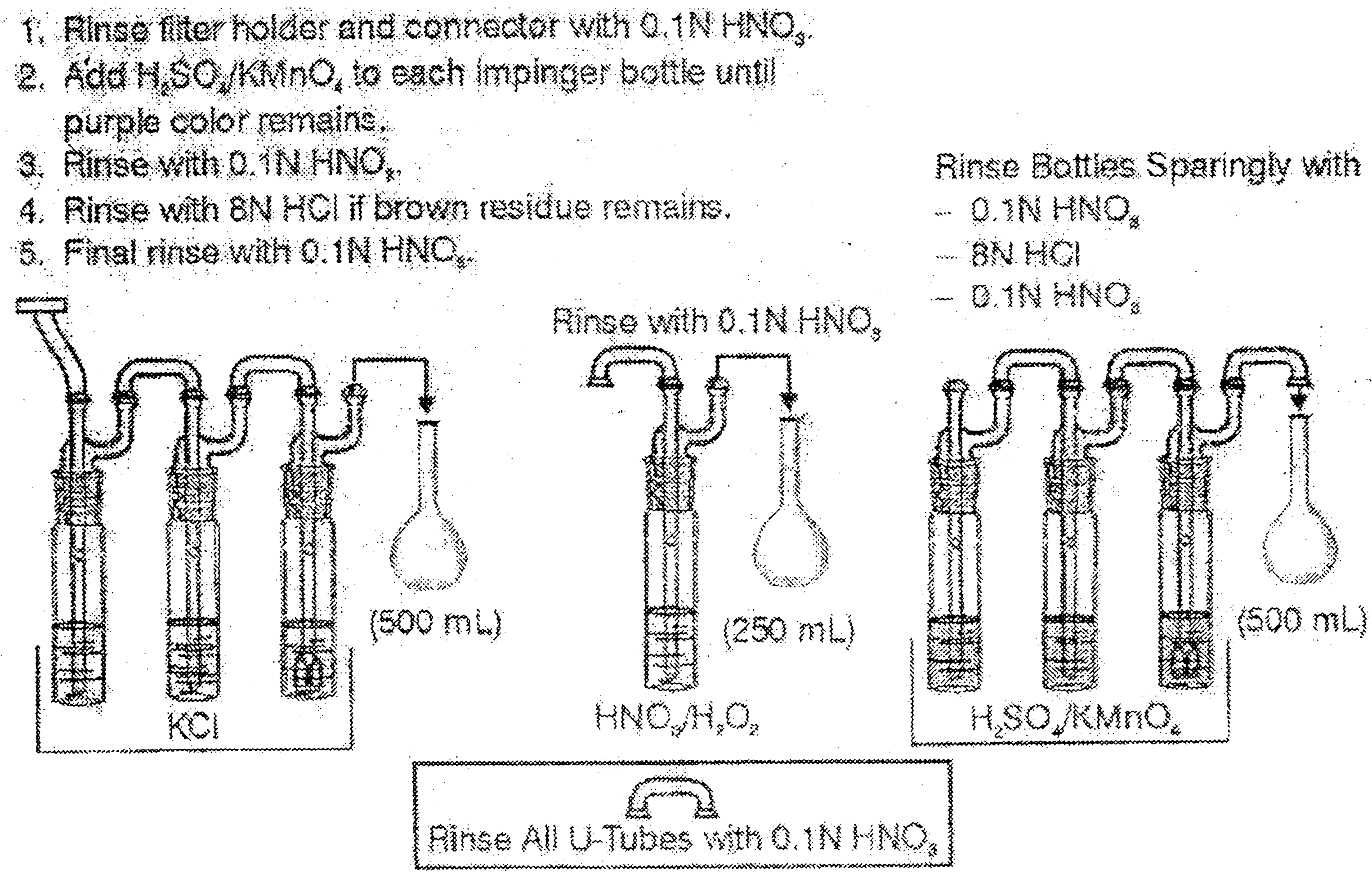


Figure 4.1-2 Recovery Scheme for Ontario Hydro Method

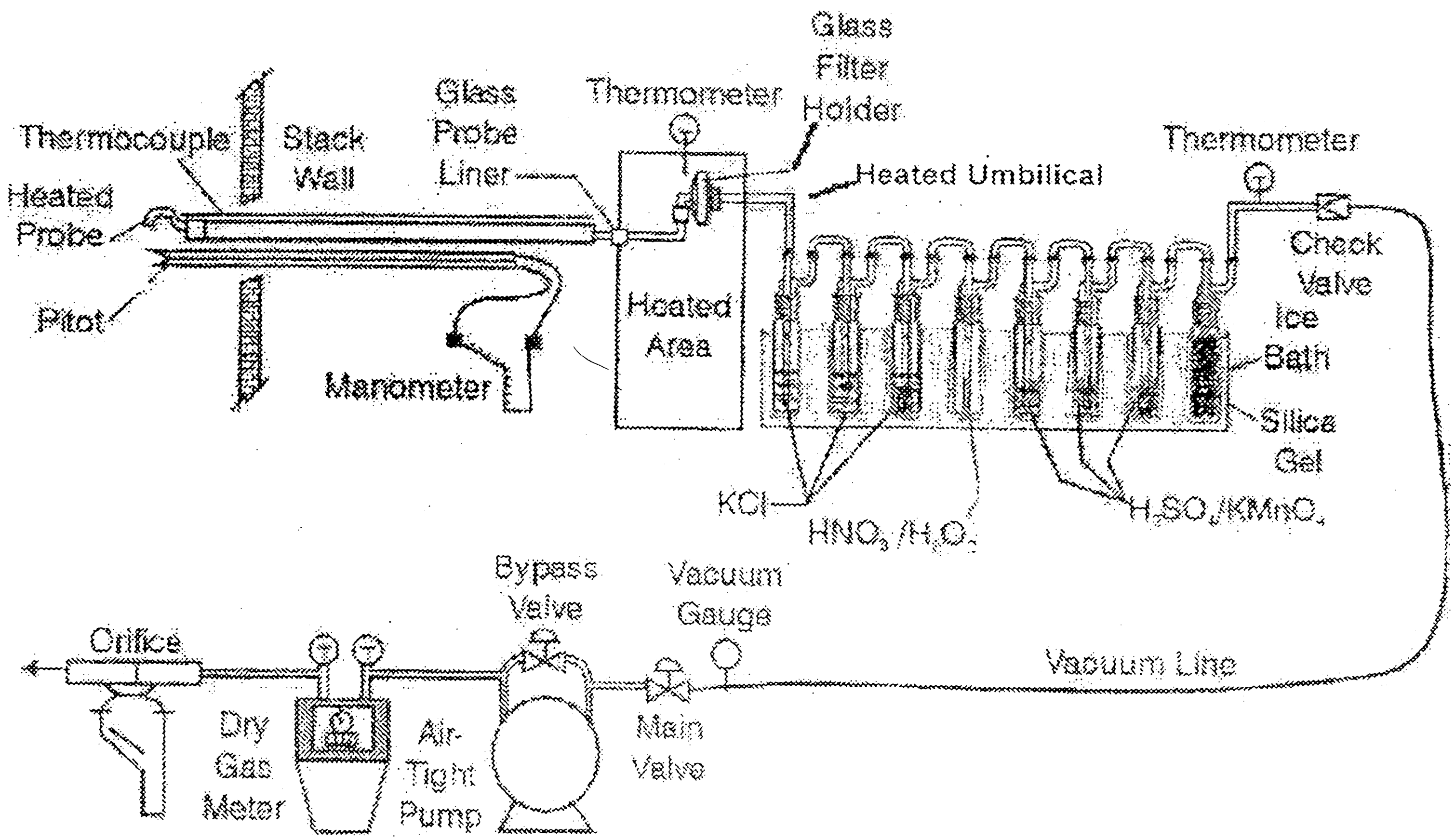


Figure 4.1-1 Schematic of Ontario Hydro Sampling Train

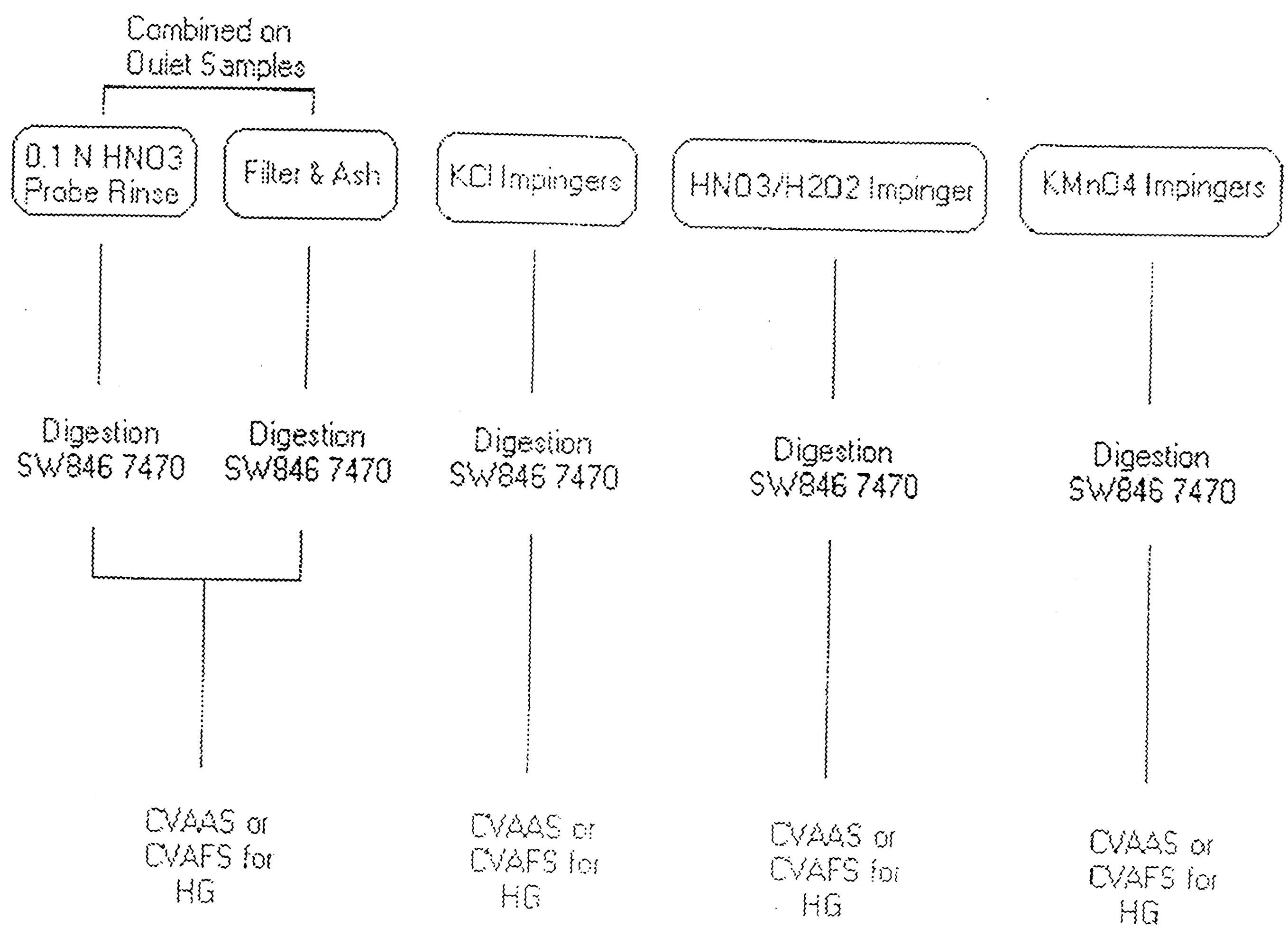


Figure 4.1-3 Schematic of Ontario Hydro Analysis

4.2.1 Standard Practice for Collection of a Gross Sample of Coal

ASTM Method D2234-99 involves taking samples of the coal feed just prior to the entrance into the boiler. The samples were taken at 10-minute increments throughout each test run. The samples were placed in a large sealed container and then homogenized, before a final ~ 2-liter sample was obtained for laboratory analysis.

5.0 QA/QC Activities

5.1 QC Problems

Upon performing the post-test calibration on the dry gas meter for the Inlet sample location (RAC #6), it was found that the meter exceeded the ± 0.05 limit for the meter correction factor. The pre-test value for the meter was 0.9882 and the post test value was 0.9320 yielding a difference of 0.0562. Therefore, the post test value of 0.9320 was used for calculating the results for the inlet samples.

All other QC checks were within acceptable limits.

5.2 QA Audits

An audit sample of Mercury in Coal Fly Ash was submitted to each analytical laboratory. The Audit samples were obtained from the National Institute of Standards and Technology. The results for each laboratory is presented in Table 5.2-1

TABLE 5.2-1 Mercury in Coal Fly Ash Audit Results

Laboratory	Results mg/kg	NIST Value
Philip Analytical	0.150	0.141
Standard Laboratory	0.120	0.141